

# THE COMMUNICATING VEINS OF THE LOWER LEG AND THE OPERATIVE TECHNIC FOR THEIR LIGATION

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THE superficial venous systems of the lower leg, the long and short saphenous veins, are connected directly with the deep venous systems, the posterior tibial, anterior tibial, peroneal and popliteal veins by a series of communicating veins. These vessels are not to be confused with the perforating veins that actually pass through the deep fascia. The following distinctions should be made between them: The former are the main venous trunks which join directly with the deep veins. They extend inward along the intermuscular fascial planes from the outer surface of the muscles. The latter, on the other hand, are the vessels which actually pass through the deep fascia and connect with the superficial veins.<sup>1</sup> In many instances the perforating veins may be a direct continuation of the communicating veins, but frequently several of them may unite beneath the deep fascia to form one of the latter. Occasionally veins will be found that drain blood from the muscles through the deep fascia to the superficial venous systems (Fig. 2). Since this type of vein does not directly connect the deep and superficial venous systems it is not a communicating vein, but on the other hand it should be termed a perforating vein. The communicating vessels also present more constant anatomic relations, that is, they are found along definite intermuscular septa, while the perforating veins vary considerably in the points at which they pass through the deep fascia (compare Figs. 1 and 2).

In the normal state the communicating veins have valves which permit the blood to pass only from the superficial to the deep systems. In many cases of varicose veins, especially those following deep phlebitis, these valves become incompetent, allowing blood to flow in either direction. This abnormal condition often is associated with varicose ulcers. To effect a cure in such cases it is necessary to interrupt the communicating veins in addition to performing a ligation and injection of the involved saphenous systems, according to the method that has been described by Faxon.<sup>2</sup>

The best description of the communicating veins in the lower leg was given by von Loder,<sup>4</sup> a Russian anatomist, in 1803. Since then very little has been added to the anatomy of these veins. Both Rémy,<sup>5</sup> in 1901, and Meisen,<sup>6</sup> in 1932, reproduced Loder's drawings in their books on varicose veins to show the usual distribution of the communicating veins in the lower leg. However, the descriptions by these men, also the ones by Braune<sup>1</sup> and Klotz,<sup>3</sup> and those in the standard textbooks of anatomy were found to be incomplete.

Since a more accurate knowledge of these veins was found necessary for the proper treatment of varicose veins and ulcers, a study of them has been carried out. The purpose of this paper is to describe: (1) The anatomic relations

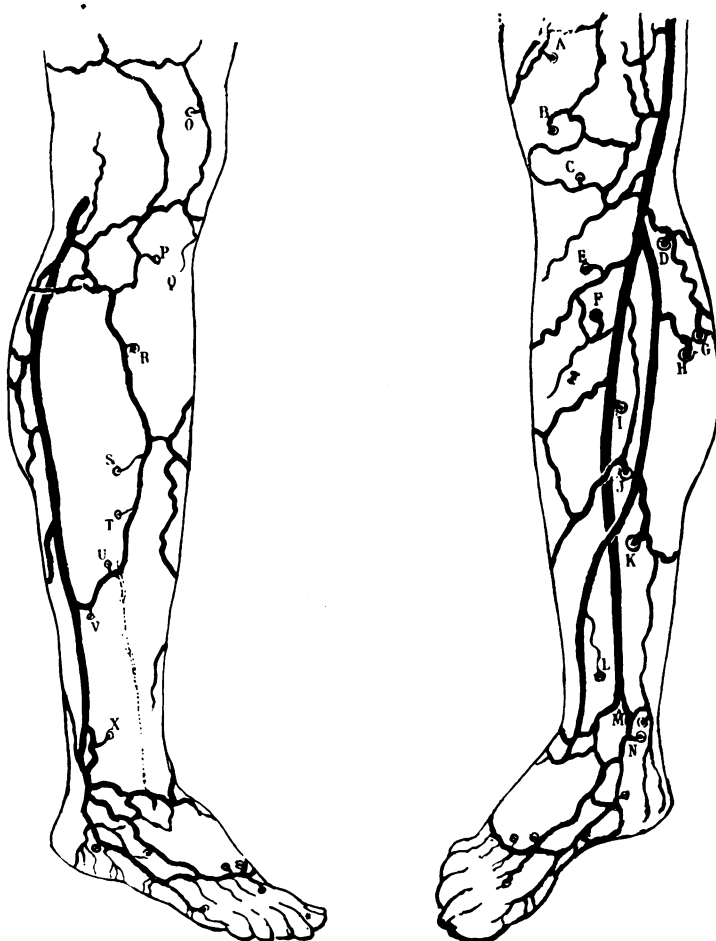


FIG. 1.—Communications (perforating veins) to the deep veins on the medial and lateral surfaces of the leg (after Loder according to Rémy<sup>6</sup>). They are represented by the letters enclosed within circles. Note that the dissections in these specimens are on the superficial aspect of the deep fascia while in Figs. 2, 3 and 4 they are beneath the deep fascia.

of the communicating veins of the lower leg; and (2) the operative technic for their ligation.

*Anatomy.*—The following anatomic facts are based upon data from the dissections of ten lower legs and on the findings in a series of 50 operations for the ligation of the communicating veins. In the dissected specimens, all of the veins of the leg were injected through one of the superficial veins over the dorsum of the foot. A suspension of barium sulphate in water was employed. The veins became filled with the white barium salt which made them readily visualized during the dissection.

The communicating veins of the lower leg connect the long and short saphenous systems with the posterior tibial, the anterior tibial, peroneal and popliteal veins. They may occur singly or in pairs. It was found that there is a fairly constant number of them in the lower leg and that they present definite relations to the other structures of the leg. In the normal state they are thin-walled and vary from a fraction of a millimeter to about 2 Mm. in diameter. When incompetent they are thick-walled and it is not uncommon to find them .5 cm. in diameter.

For descriptive purposes they have been divided into the posterior tibial, anterior tibial, peroneal, and popliteal groups.

*The Posterior Tibial Communicating Veins.*—This series of veins is found on the inner or medial aspect of the lower leg (Fig. 2). They arise from either of the posterior tibial veins, the uppermost ones being found about the middle of the proximal third of the lower leg. They pass outward along the intermuscular septum between the flexor digitorum longus and the soleus muscles, passing through some of the fibers of the latter near its attachment to the posteromedial edge of the tibia. They frequently arise as double veins and as they approach the deep fascia, may unite to form one trunk and then break up into a variable number of branches. Some of these pass to adjacent muscles while others perforate the overlying deep fascia to connect with the long saphenous vein or its tributaries. There are usually two sets of these veins in this portion of the lower leg (Fig. 2).

In the middle third of the lower leg one or two sets of communicating veins are found. These arise and pass outward in a similar manner to the previous ones except that they do not pass through the soleus muscle since they arise below its origin to the tibia. In the distal third of the leg there are three or four communicating veins. The lowest one lies at the level of the lower border of the malleolus and posterior to it. The upper ones pass outward along lamina profunda of the deep fascia of the leg which separates the posterior tibial vessels and nerve, the flexor digitorum longus and tibialis posticus muscles and their tendons, from the soleus muscle and the Achilles tendon (Figs. 2 and 5). Usually they perforate the deep fascia posterior to the posteromedial edge of the tibia and pass forward to join the long saphenous vein over the crest of the tibia.

*The Anterior Tibial Communicating Veins.*—These vessels arise from the anterior tibial veins and communicate with both the long and short saphenous systems, but chiefly with the former. They are found on the anteromedial, anterior, and anterolateral surfaces of the lower leg. They should be divided into three subdivisions: the medial, the central and the lateral. The medial one consists of three or four small paired veins which are normally about 0.5 Mm. in diameter. They are found in the middle two-thirds of the lower leg and pass posterior to the tibialis anticus muscle and the tibia, after passing through the interosseous membrane. They extend forward on the inner aspect of that bone in very close association with the periosteum (Figs.

FIG. 2

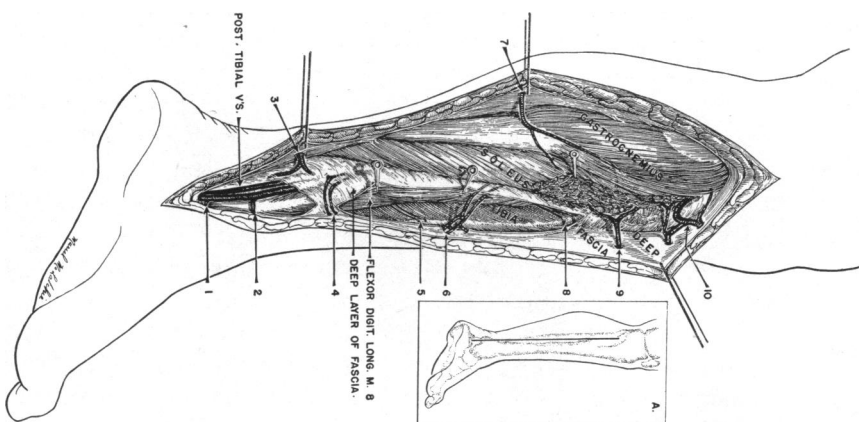


FIG. 3

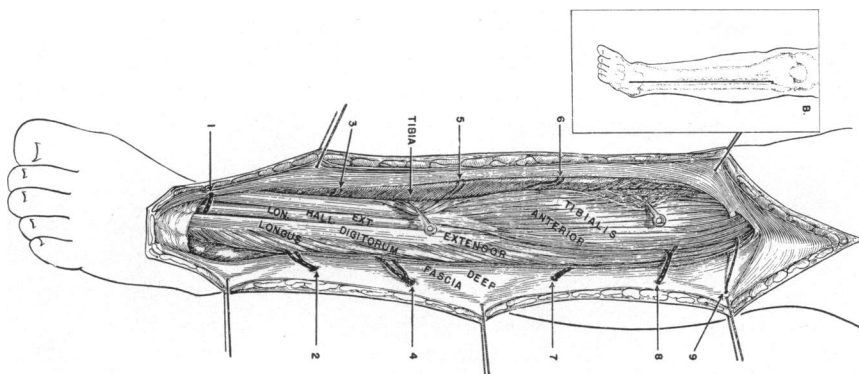


FIG. 4

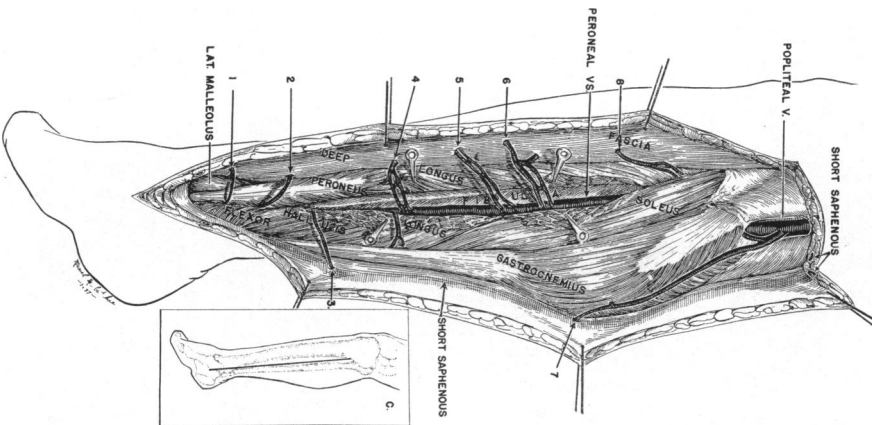


FIG. 2.—A dissection of the medial aspect of the lower leg to show the medial group of communicating veins. The deep fascia has been divided longitudinally on the medial side of the lower leg posterior to the tibia, and dissected from the muscles both anteriorly and posteriorly. In the upper portion of the leg the soleus muscle has been partially divided. The lower half the lamina profunda of the deep fascia has been cut exposing the posterior tibial artery and veins, and the flexor digitorum longus muscle. The latter muscle has been retracted to expose the medial side of the tibia. Nos. 1, 2, 3, 4, 6, 9 and 10 are posterior tibial communicating veins. Nos. 5 and 8 belong to the medial subdivision of the anterior tibial communicating veins. No. 7 represents a perforating vein which drains blood from the muscle through the deep fascia to the superficial veins. The inset shows the incision used in the operation for the ligation of these veins.

FIG. 3.—A dissection of the anterior aspect of the lower leg to show the lateral group of communicating veins. Nos. 1, 2, 4, 7, 8 and 9. The tibialis anterior muscle is retracted laterally to show the lateral subdivision between the tibia and fibula on the anterolateral surface of the lower leg, and the anterior peroneal intermuscular septum has been divided longitudinally. Nos. 3, 5 and 6 on the lateral aspect of the tibia. The inset shows the incision used in the operation for the ligation of these veins.

FIG. 4.—A dissection of the posterolateral aspect of the lower leg to show the peroneal communicating veins. Nos. 1, 2, 3, 4, 5, 6 and 8. Posteriorly, the deep fascia has been elevated to show the popliteal communicating vein. No. 7. The short saphenous vein is shown superficial to the deep fascia with communicating veins Nos. 3 and 7 emptying directly into it. The inset shows the incision used in the operation for the ligation of these veins.

2 and 5), and perforate the deep fascia over the anteromedial surface of the tibia to join the long saphenous system of veins.

The central subdivision consists of a series of veins similar to the first except that they pass only posterior to the tibialis anticus muscle and then run forward on the lateral surface of the tibia (Figs. 3 and 5). They perforate the deep fascia just at the outer edge of the tibia to anastomose with the superficial veins. In the dissections and at the operations, the veins of these two subdivisions were very rarely found to be enlarged or incompetent, but since these veins may be involved and as they are always present, they should be exposed at operation.

The lateral subdivision consists of a series of larger communicating veins which are found on the anterolateral surface of the leg. There are five to six in this group. The highest one lies a short distance below the head of the fibula. The upper one or two veins pass outward between the tibialis anticus and extensor digitorum longus muscles. The others except for the lowest one come out along the anterior (peroneal) intermuscular septum between the extensor digitorum longus and the peroneus longus muscles (Fig. 5). The most distal one of this subdivision emerges between the tendons of the extensor hallucis longus and extensor digitorum muscles just above the annular ligament of the ankle joint (Fig. 3). These veins anastomose with the superficial veins in this region that may be tributaries of either the long or short saphenous veins.

*The Peroneal Communicating Veins.*—The vessels in this group arise from the peroneal veins and connect them with the short saphenous system on the posterolateral surface of the leg (Fig. 4). They vary from six to seven in number. The uppermost one is found about 2 or 3 cm. below the head of the fibula and the lowest at the level of the lateral malleolus. In the upper one-half of the lower leg they emerge along the intermuscular septum which separates the peroneus longus and soleus muscles (Fig. 5). They give off a number of muscular tributaries as well as perforating branches. In the lower one-half they pass outward between the peroneus longus and flexor hallucis longus muscles.

*The Popliteal Communicating Vein.*—This vein is not a constant finding but frequently it is present. It arises from the popliteal vein between the two heads of the gastrocnemius muscle and descends with the lateral division of the sural nerve to about the upper part of the middle third of the leg. It pierces the fascia at this level to join the short saphenous vein after giving off a number of branches to the gastrocnemius muscle (Fig. 4.) Frequently the vein which perforates the fascia at this point arises directly from the gastrocnemius muscle and simply drains blood from it into the short saphenous vein. In such cases it is not a true communicating vein.

*Operative Technic.*—The communicating veins have been divided into three main groups: the medial, the anterior and the lateral, to facilitate their surgical exposure. The medial group is found on the inner side of the lower leg. It consists of the posterior tibial and the medial subdivision of the

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anterior tibial communicating veins. The anterior group is on the anterolateral surface of the lower leg. It is made up of the central and lateral subdivisions of the anterior tibial communicating veins. The lateral group is situated on the posterolateral surface of the lower leg and consists of the peroneal and popliteal communicating veins.

*Preoperative Preparation.*—The skin and subcutaneous tissues of the lower leg in cases of incompetent communicating veins often are edematous and present a chronic infection or ulceration. Operation should not be performed until the edema and infection have disappeared and the ulceration healed for six weeks. This is accomplished by placing the patient in bed and elevating

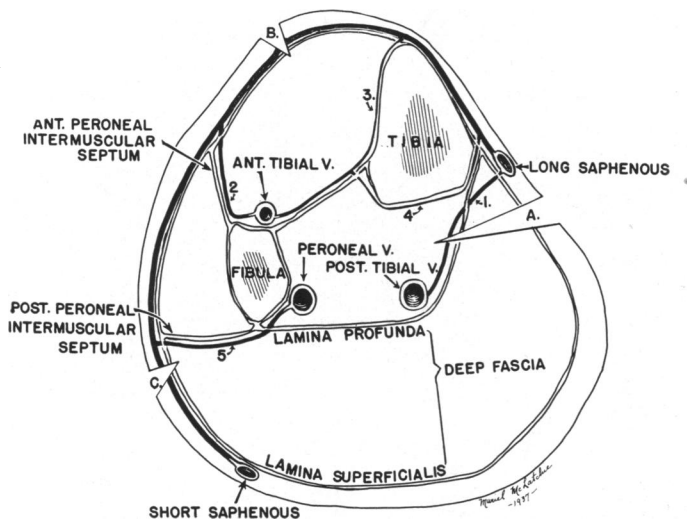


FIG. 5.—A diagrammatic drawing of a cross section of the lower leg at the junction of the lower and middle thirds, to show the relationships of the communicating veins to the deep fascia and the intermuscular septa. No. 1 represents a posterior tibial communicating vein. Nos. 2, 3 and 4 represent communicating veins respectively of the lateral, central and medial subdivisions of the anterior tibial communicating veins. No. 5 represents a peroneal communicating vein. Letters A, B and C show respectively the locations of the operative incisions for the medial, anterior and lateral groups of communicating veins.

the affected extremity on pillows so that it rests on a level slightly above that of the heart. If the ulcer is a large one, healing will be hastened by covering it with a large "Thiersch" skin graft. This will grow rapidly and survive as long as the leg is kept in an elevated position or securely bandaged. All open lesions should be cultured for the hemolytic streptococcus. If it is present, grafting should be delayed until this organism has been eradicated with moist dressings.

In addition to bacterial infections; the skin in the lower leg may present an itchy vesicular rash. This is due to a fungus infection. It rapidly clears up with daily applications of a solution containing one-tenth of 1 per cent thymol and 2 per cent each of resorcinol and benzoic acid in 95 per cent ethyl alcohol.

After all ulcerations are healed and the infection cleared up, a ligation of the long saphenous vein and its branches at the saphenofemoral junction is

done. The short saphenous vein, if it is involved, should also be ligated at its termination in the popliteal vein.

When it is evident the skin graft has taken, usually in about two weeks, an elastic adhesive (Elastoplast) bandage is applied from the toes to the knee. It is placed directly over the ulcer area. The patient is allowed up and discharged home in a few days. The bandage is renewed after three weeks. At the end of six weeks, the skin is usually in a satisfactory condition for the ligation of the communicating veins.

*Anesthesia.*—The anesthetic of choice is spinal anesthesia. Our technic has been to use 150 mg. of novocain crystals dissolved in 3 cc. of spinal fluid. This is injected through the third or fourth lumbar space. It should be done with the patient lying on the side which is to be operated upon.

*The Position of the Patient.*—This is very important, as the correct position simplifies the operation by giving proper exposure. If the medial group of veins is to be ligated, the patient should be placed in the Sims' position lying on the side with the affected extremity. This gives an excellent exposure of the medial side of the lower leg. If the anterolateral group is to be operated upon, the patient lies on his back and for the posterolateral group he is placed face downward with the feet everted.

The incisions for all three groups should be made in a straight line and parallel to the long axis of the leg (insets Figs. 2, 3 and 4). In each instance it is carried through the deep fascia down to the muscles and tendons. Many superficial varicosities are severed but these demand no special attention other than ligation of them. As soon as the incision has been completed in its entire length the wound is protected from contamination by the use of towels attached to the skin. As it is very important to avoid trauma to the skin edges, the towels are held in place by a continuous silk suture as shown in Fig. 6.

*Ligation of the Medial Group of Communicating Veins.*—The incision for operation on the medial group of veins is made on the inner side of the lower leg. It should extend from the level of the lower border of the medial malleolus, midway between it and the internal tubercle of the os calcis, to just below the upper end of the tibia and about a thumb's breadth posterior to the medial edge of that bone (inset Fig. 2). It is important to make the incision straight even though it must go through old scarred tissue or a healed ulceration. In some cases it is permissible to curve the incision slightly to skirt the edge of a healed ulcer, but it should not be carried too far posteriorly as this may result in sloughing of the anterior skin edge.

After the division of the deep fascia the gastrocnemius and soleus muscles are visible in the upper and middle thirds of the incision. In the lower third the Achilles tendon and the lamina profunda of the deep fascia covering the posterior tibial nerve, artery and vein, also the tendons of the tibialis posticus and flexor digitorum longus muscles are brought into view (Fig. 6).

When the skin has been covered with towels, the dissection is carried forward by elevation of the anterior edge of the wound. This is done by

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traction on hemostats applied to the cut edge of the deep fascia (Fig. 6). Small rake retractors may also be used but the skin should never be picked up with forceps, as this may produce sufficient trauma to cause a slough.

The dissection is carried forward beneath the deep fascia to the medial edge of the tibia. This is done with great facility as the operative field is bloodless except for the communicating veins and arteries. Beginning in the upper third of the leg these vessels are isolated, divided and tied beneath the deep fascia. The arteries accompanying the veins are so small it is not necessary to preserve them. The uppermost communicating veins emerge through some of the fibers of the soleus muscle. After dividing and tying these proximal ones the dissection is carried toward the foot. The veins at the junction of the middle and lower thirds are the ones most frequently found incompetent. In the lower one-half of the leg it is necessary to divide longitudinally the lamina profunda of the deep fascia (Fig. 6). By doing this the deep vessels and nerves and the tendons of the posterior tibial and flexor digitorum muscles are brought into view. Frequently the communicating veins can be readily traced to their origin from the posterior tibial veins.

The dissection behind the medial malleolus is the most difficult because the communi-

cating veins are very short and the tissues even though normal are very taut and rigid which permits very little retraction. Great care must be exercised not to injure the posterior tibial vessels and nerve because at this level they lie immediately beneath the fascia. The posterior tibial veins are usually

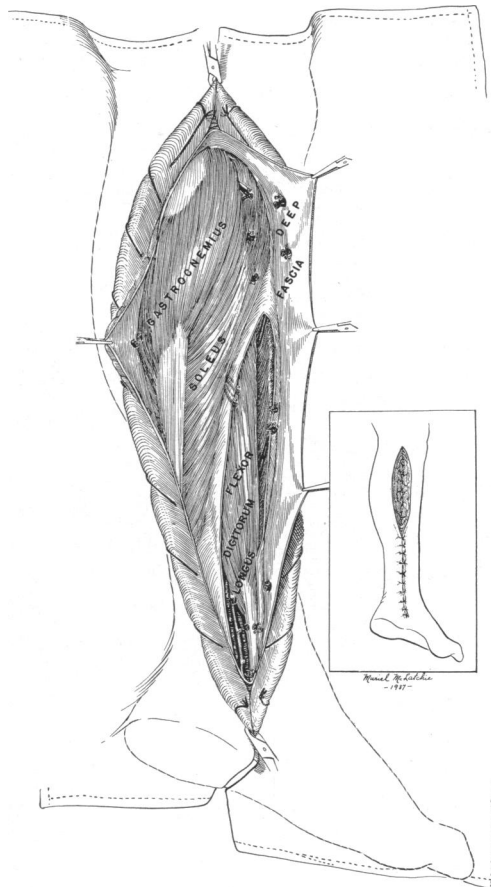


FIG. 6.—An operative sketch to show the method of ligation of the medial group of communicating veins. Note the use of towels sewed to the skin edges to protect the wound from contamination by the skin, and the retraction of the skin and deep fascia by means of hemostats attached to the latter. Posteriorly the fascia has been elevated sufficiently to permit ligation of the popliteal communicating vein. The lamina profunda or deep layer of the deep fascia has been divided. This brings into view the posterior tibial vessels, nerve and flexor digitorum longus muscle. This step is necessary in order to reach the communicating veins in the lower one-half of the leg. This muscle has been retracted bringing into view the inner side of the tibia and the medial subdivision of the anterior tibial communicating veins. The inset shows the method of closure of the wound with interrupted stitches.



found relatively large and tortuous and should not be mistaken for varicose communicating veins.

After ligation of all the communicating vessels in this area the inner edge of the tibia is next visualized from just above the medial malleolus to almost the junction of the upper and middle thirds of the leg. This step is necessary in order to visualize the medial subdivision of the communicating veins from the anterior tibial vessels (Fig. 6). In the proximal part of the operative field it may be necessary to free the soleus muscle from the medial edge of the tibia so that the upper veins of this group may be seen.

Ligation of these veins, if dilated, may be difficult because they are so adherent to the periosteum of the tibia. The most satisfactory procedure is to incise the periosteum on both sides of the dilated vein. A ligature can then be readily passed around the vein by elevating it with the periosteum. If these vessels are found to be normal in size they are not ligated.

The posterior edge of the wound should also be elevated as there may be communicating veins in the lower portion of it (Fig. 2). Opposite the middle of the lower leg the fascia is elevated sufficiently far enough to ligate the communicating vein from the popliteal vein which lies between the two heads of the gastrocnemius muscle (Fig. 6).

After the ligation of the communicating veins is complete, the wound is thoroughly washed out with normal saline solution. Then the deep fascia is sutured with interrupted stitches of No. 5 silk (inset Fig. 6). This is an important step because these sutures prevent tension on the skin stitches which, if present, would interfere with healing. Interrupted sutures of fine silk are also used for the skin. Silver foil is placed directly over the closed wound and a large gauze dressing applied.

*Ligation of the Anterior Group of Communicating Veins.*—The incision for the exposure of these veins is made in a straight line midway between the tibia and fibula from the level of the upper end of the latter bone to that of the lateral malleolus (inset Fig. 3). After dividing the deep fascia the tibialis anticus muscle is seen in the incision. Lateral to it lie the extensor digitorum longus and the peroneus longus muscles.

The veins of the central subdivision of the anterior tibial group are exposed by retracting the tibialis anticus muscle laterally. This exposes the lateral surface of the tibia in all except the upper one-sixth of the bone. The communicating veins are readily visualized on the periosteum (Fig. 3). If they are dilated, they are ligated in a manner similar to that described above for the ones on the medial side of the tibia. If they are normal, as they are in most cases, they need not be disturbed.

The veins of the lateral subdivision are found by dividing the anterior (peroneal) intermuscular septum which separates the peroneal muscles from the extensor digitorum longus muscle (Fig. 5). The dissection is carried distally to the lower edge of the lateral malleolus. All the communicating veins are ligated and divided. The wound is then cleansed with normal saline and closed with interrupted silk sutures in the fascia and the skin.

*Ligation of the Lateral Group of Communicating Veins.*—The incision for the exposure of this group of veins is made in a straight line posterior to the lateral malleolus midway between it and the lateral tubercle of the os calcis. It should extend vertically upward on the posterolateral surface of the lower leg from the lower border of the malleolus to the upper third of the lower leg (inset Fig. 4).

After dividing the deep fascia, the Achilles tendon and the lower fibers of the soleus muscle will be recognized in the posterior and distal portion of the wound. The peroneus brevis and longus muscles and tendons lie anteriorly separated from the gastrocnemius and soleus muscles by the posterior (peroneal) intermuscular septum along which the communicating veins will be found. The short saphenous vein is usually encountered and divided in the lower end of the incision. The sural nerve accompanies this vein and care should be taken not to injure the nerve. The dissection may be carried posterior in the midportion of the leg in order to ligate the popliteal communicating vein. The operative wound, as in the other incisions, is closed with interrupted silk in the fascia and the skin.

*Postoperative Treatment.*—After the dressing has been applied, the foot and ankle are immobilized by applying a posterior plaster splint from the toes to the knee to aid primary wound healing. The foot is placed in dorsiflexion and as nearly as possible at a 90° angle with the lower leg.

The patient is kept in bed for a period of 10 to 14 days or longer depending on the condition of the wound. The dressing is not changed until the tenth day, unless there are signs of wound infection. Every alternate stitch is removed at this time and the remainder of them are taken out on the twelfth day.

A certain amount of edema of the lower legs may appear after the patient becomes ambulatory. To reduce this to a minimum the following measures are taken. First, before the patient is permitted to be up and about he carries out postural leg exercises for three to four days, to reestablish normal circulatory tone and to prevent the development of peripheral edema. These exercises are a modification of those described by Buerger<sup>7</sup> and Allen<sup>8</sup> in that the period of elevation is longer than the period of dependency. They are done by elevating the legs to a 30° or 40° angle with the horizontal for a period of three minutes. Then the lower legs are hung over the side of the bed for two minutes. This is followed by a five minute rest with the legs in the horizontal position. The exercises are done in half-hour or hourly periods for a total of three or four hours a day. Second, when the patient is allowed out of bed, the legs are bound firmly from the instep to the knee with an elastic adhesive (Elastoplast) bandage. Third, he is instructed when sitting to elevate his legs on another chair. Walking is begun for very short periods and increased gradually. Most patients wear supporting bandages for one month to six weeks following discharge from the hospital.

*Discussion.*—The communicating veins of the lower extremity have been

described anatomically and divided into three main surgical groups: The medial, the anterior and the lateral. The purpose of this classification is to simplify the surgical approach to them in varicose conditions of the lower leg.

Ligation of the perforating veins has been advocated for many years; Rémy,<sup>5</sup> in 1901, Homans,<sup>9, 10</sup> in 1916 and 1917, and Trout,<sup>11</sup> in 1929, have stressed the importance of this fact. It should also be noted that a procedure termed the "flap" operation for the ligation of the perforating veins has been carried out at the Massachusetts General Hospital for a number of years. The operation consisted in making a curved incision on the lower leg where the incompetent perforating veins were found. This permitted the elevation of a flap of skin and fascia so that the veins could be ligated beneath it. Neither the technic nor the results of this operation have been described in the literature. This is probably because the use of a curved incision with the actual formation of a flap of skin and fascia frequently resulted in sloughing of the skin edge. The incision as a result often required weeks, months, or longer to heal so that the operation fell into disrepute.

Since it is imperative to interrupt the communicating veins if they are incompetent, it was felt expedient to develop an operative procedure that would eliminate the faults of the old operation. The operative technic is given in detail. Through three properly placed incisions, it is possible to ligate all of the communicating veins in the lower leg. If the precautions described are taken, these wounds heal by primary intention.

All the communicating veins are rarely found to be incompetent. However, it is not unusual to find that two groups in the same leg may be affected. The medial group is the one most commonly at fault. In about 80 to 90 per cent of the cases with incompetent communicating veins, this group is involved. In 15 per cent the lateral group and in 5 per cent the anterior group are incompetent. The increased frequency of incompetence in the medial group probably is because the posterior tibial veins, from which the medial group arises, lie relatively superficial in the distal half of the lower leg. Thus the communicating veins pass outward chiefly through tendinous structures that give them little support. On the other hand, the anterior tibial and peroneal veins lie more deeply among the muscles of the leg. The communicating veins from these two systems pass outward between muscular structures and accordingly receive greater support than those of the medial group. The clinical examination will usually suffice to indicate which group of veins requires ligation.\* High ligation of the long saphenous vein and short one if it is incompetent should be performed prior to the ligation of the communicating veins.

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\* Another paper is to be published on the indications for the operation and case reports.

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